Course _____   Name _____
Date _____

Quasars and Large Dataset Activity

Objectives:

- Create and interpret scatterplots and histograms

- Use a spreadsheet program to identify limitations of datasets

- Use a histogram to categorize data

Background

Quasars are galaxies with a supermassive black hole (SMBH) that is actively accreting matter from a disk. This material is gas and dust, typically due to a collision between two galaxies. As some material flows into the SMBH, some material remains in a disk around the black hole, and some is ejected in jets that leave the galaxy. Quasars tend to be much brighter with visible light than other galaxies located at the same distance away from us. Those galaxies with strong jets will also have strong radio emission, while galaxies with weak or non-existent jets will have no detectable radio emission.

In this lab, we are going to be analyzing a large set of data about quasars: where in the sky they're located, how far away they are, and how bright they are in radio light. (While these quasars were originally found with visible light, that information is not presented here.) Because we have nearly 200 of these quasars, we can't actually do this analysis by hand, so we're going to use a spreadsheet to answer these questions. Specifically, we'll be using Google Spreadsheets, which is really similar to MS Excel if you've used that, but GSheets actually has a couple features that make it better for this task than Excel.

Procedure

This activity is split into three parts, followed by an optional demographics sheet and a post-test. You may hang on to this sheet throughout all the parts. As your group finishes each part, please turn it in and pick up the next part.

Group _____   Name _____
Date _____   4-digit Code _____

Quasars and Large Dataset Activity

Part I

1. Go to the webpage http://tinyurl.com/quasardata . This should open a Google Spreadsheet titled "Quasar Data".

2. You will need to have a Google account to participate in this activity. If you do not already have one, you can log in as
   Username: QuasarStudy
   Password: apple123bike

3. Since you can't edit this file, you need to make a copy for yourself to work on. Click on "File", then "Make a Copy…" When it prompts you for a new file name, put in your first and last name.

4. Each row is a different quasar – you can think of these like different people in a database. Each column is a description of that quasar. Column A is the name of that quasar, Columns B and C are Right Ascension and Declination (like longitude and latitude of where a person lives), Column D is the redshift (how far away it is). And FIRST is the brightness of the object in radio light – here a "0" means it wasn't detected at all.

5. Take a look through the data, scrolling up and down. Describe what you see. Does anything pop out at you?

6. What would you do if your boss gave you this dataset and told you to summarize it?

If you have agreed to participate in the study, please provide your contact information so we can schedule a follow-up interview.

Email: _____

Phone: _____

Part II

1. Now, I want you to look specifically for trends. Are there any numbers that are very common in a particular column? (If so say which column.) Any trends in the other columns?

2. Can you sort the data in any way? If so, what do you see?

3. If you could draw this data as a graph, what would you draw?

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Part III

The next steps will talk you through examining the trends in more detail, using the capabilities of the spreadsheet.

- http://tinyurl.com/quasardata
- Username: QuasarStudy
- Password: apple123bike

1. First let's look at their position in the sky, which are RA (longitude) and Dec (latitude). Highlight these columns by click-dragging from B to C, then click Insert > Chart… (Note that if you click on B and then shift-click on C, the next step won't work right!)

2. When the Chart Editor pops up, click on the tab named Charts (it's between Start and Customize). On the left pick Scatter, then click on the picture with red and blue dots. Then click on the Customize tab, give the chart an informative title (What are you plotting?), and put "RA (degrees)" and "Dec (degrees)" on the horizontal and left vertical axes, respectively. Click Insert when you're done.

3. Let's make this a separate tab so it doesn't get in the way of the data. In the upper right of the graph is little down arrow. Click it and pick Move to Own Sheet… Rename the tab to something informative and short.

4. In reality quasars appear all over the sky (that is, you should see dots evenly spread out over the whole graph). If however, the telescopes that took this data were only looking at parts of the sky, then astronomers would say that this is not an all-sky survey. Do you think that this is an all-sky survey or not? Explain your answer.

5. Now we're going to look at the redshift, which is a measurement of how far away the quasars are. Go back to the tab labeled Data. Click on the redshift column so only that column is highlighted. Click on Insert > Chart…

6. Keep the bar graph that pops up, we'll be using this default type of graph for the rest of this activity.

7. Click on the Customize tab. Name the chart, label the horizontal axis with "Redshift (z)", and label the left vertical axis with "Number", then click Insert. As before, turn this into its own tab so it doesn't block the data.

8. This graph is what's called a histogram, and it shows you how many objects are in each range of values. You've probably seen histograms of student scores on an exam before:
Source: http://bolt.mph.ufl.edu/files/2012/07/images-mod1-histogram1.gif

Histograms are good for understanding what values are most common or least common. Astronomers call this the distribution of values.
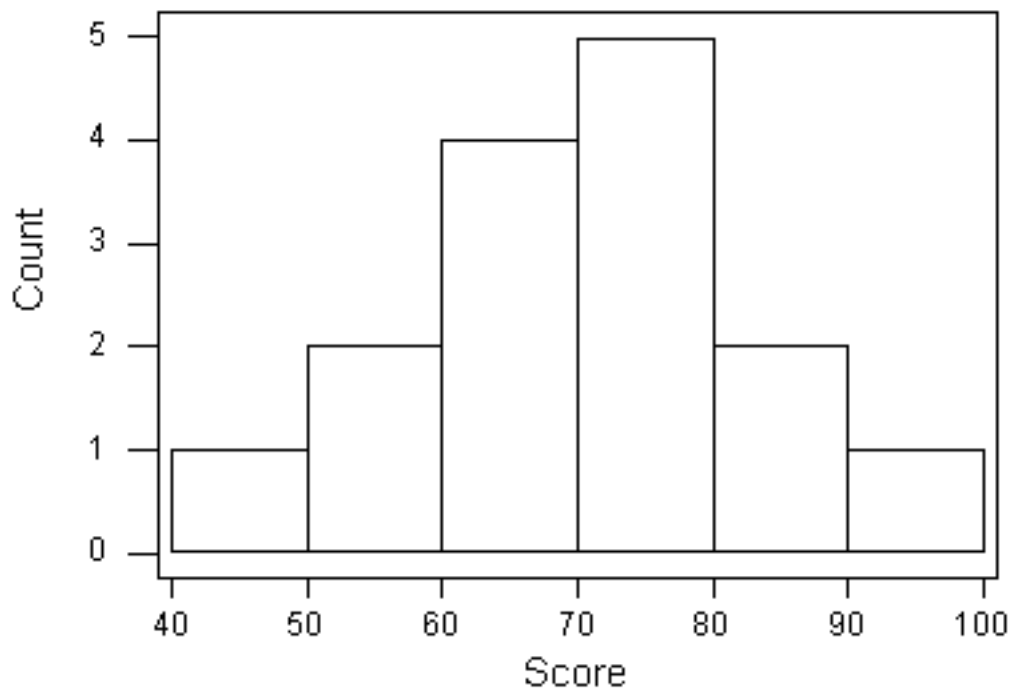
9. At what redshift range do we find the most quasars? _____

10. Give a reason why we might find fewer quasars if we go to a higher redshift (remember, a higher redshift is further away and longer ago).

11. Give a reason why we might find fewer quasars if we go to a lower redshift (closer distance, more recent).

12. Repeat steps 5-7 to create a histogram for the FIRST (radio) magnitudes.

13. In this particular column, a "0" is used to indicate that the quasar had no radio emission. Do you see any obvious groups or trends here, or are things pretty much flat? Are most quasars bright in the radio or dim? Can you create any categories for quasars based on their radio emission? If so, describe the categories, and around what percent or fraction are in each category?

14. Please share your finished spreadsheet with me. In the upper right click the blue button labeled Share. A window named "Sharing Settings" will pop up. Near the bottom it says "Invite people". Click in the box and type my email address:

  aschwort@uwyo.edu

(note the spelling!) ALSO, click on "Add Message", and fill in the following information:

  Names of all group members:

  Course: